

EXTERIOR HEAT DISTRIBUTION

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INTRODUCTION

Exterior Heat Distribution systems are used on most DOD facilities. With six thousand miles of heat distribution piping on DOD facilities, the use of energy efficient systems is vital. This paper summarizes the status of criteria for exterior heat distribution systems and addresses recent changes to criteria for buried systems that have been implemented.

CRITERIA FOR HEAT DISTRIBUTION SYSTEMS

GENERAL

Latest design criteria policy for selection of type of exterior heat distribution systems capable of transporting steam, condensate, or high temperature hot water at temperatures higher than 250 degrees F (120 degrees C is contained in the October 4, 1994 Policy distributed to Corps offices by 11 October 1994 memorandum. Army policy for these systems mirrors Corps policy and is addressed in Army Regulation AR 420-49, Utility Services. An upcoming revision of the Corps AEI will make this criteria permanent.

The policy allows buried systems to be used only when aboveground and shallow concrete trench systems cannot be used, eliminates the use of air space systems with fiberglass casings and eliminates the use of gland type end seals.

TM 5-810-17, HEATING AND COOLING DISTRIBUTION SYSTEMS

General design criteria for heat distribution systems are contained in TM 5-810-17, Heating and Cooling Distribution Systems. The TM provides typical details for all systems including valve manholes, shallow concrete trench design, insulation thickness tables and system selection criteria. The selection policy will be incorporated into an EM that will be replacing the TM in the near future.

CEGS 02552, PRE-ENGINEERED UNDERGROUND HEAT DISTRIBUTION SYSTEM

These systems are for underground high temperature distribution systems above 250 degrees F (120 degrees C). These systems are to be used only in areas where aboveground and shallow concrete trench systems cannot be used. This specification is an updated version of CGES 02695 which changed requirements from using prequalified systems to a performance type of specification with requirements included that will ensure that these systems will give us the best performance we can expect. The specification covers the designing, furnishing, installing and testing requirements but does not address the design of valve manholes which are addressed in CGES 02699.

CEGS 02554, ABOVEGROUND HEAT DISTRIBUTION SYSTEM

This specification number was recently changed from CGES 02697. Aboveground type heat distribution systems are always preferred if acceptable to the user. The specification provides requirements for piping, insulation and protective covering as well as supports.

CEGS 02555, PREFABRICATED UNDERGROUND HEATING/COOLING DISTRIBUTION SYSTEM

These systems are allowed in all areas. These systems can be used in low temperature heating service up to 250 degrees F (120 degrees C) as well as chilled water service. The specification requires that systems pass an end seal cycle test. The specification is an updated version of CGES 02698.

CEGS 02696, HEAT DISTRIBUTION SYSTEMS IN CONCRETE TRENCHES

Generally, shallow concrete trench systems are not to be used in areas below the water table. The specification provides requirements for piping, insulation, protective covering and waterproofing of the trench. Insulations used are those that will not be destroyed under boiling conditions. Insulation thickness tables are also included.

CEGS 02699, VALVE MANHOLES AND PIPING AND EQUIPMENT IN VALVE MANHOLES

This specification provides requirements for manholes, piping, equipment, and manhole wall penetrations. The specification is intended to be used for all heat distribution systems. It should

be noted that there are no manhole requirements in the distribution system specifications. This specification was developed in order to improve the performance of heat distribution systems.

BACKGROUND OF CHANGES TO CRITERIA FOR BURIED HIGH TEMPERATURE HEAT DISTRIBUTION SYSTEMS

ELIMINATION OF PREQUALIFICATION METHOD

Federal Acquisition Regulations require a waiver from DOD in order to use prequalified products. A request for waiver to continue with the prequalification of underground heat distributions systems (UHDS) was denied. Consequently the Federal Agency Committee on UHDS met and established guidelines for developing new criteria eliminating prequalification requirements for buried systems. It was decided that information from CERL and CRREL surveys would be used in the criteria development.

CERL AND CRREL SURVEYS OF UNDERGROUND HEAT DISTRIBUTION SYSTEMS

CERL Survey of Drainable, Dryable and Air Testable Systems:

A survey team from the U.S. Army Construction Engineering Research Laboratory (CERL) examined 35 air space type of heat distribution systems at 15 federal installations within DoD and the Department of Veterans Affairs. The team conducted almost 100 conduit air pressure tests. Tests were conducted on about the same number of systems using fiberglass conduits as well as steel conduits. Even in the absence of gland seals the fiberglass conduits performed significantly worse as compared to steel conduits. The fiberglass conduits had a failure rate 4 times greater than steel conduits. In addition to other valuable findings, it was also learned that the failure rate of steel conduits alone was significant.

CRREL Survey of Water Spread Limiting (WSL) and Loose Fill Insulation (LFI) Systems:

The U. S. Army Cold Regions Research and Engineering Laboratory (CRREL) conducted an in-depth field study of WSL and LFI types of underground heat distribution systems at 20 sites throughout the United States. This research originated because of interest in the performance of Federal Agency prequalified UHDS.

The WSL system consists of preinsulated pipe sections that are sealed on each end and uses a composite insulation with no air space between the carrier pipe and casing. Adjacent pipe

sections are joined by a coupling assembly that allows the pipe sections to expand and contract freely. The LFI system consists of installing a bare steel pipe in formed trenches, filling the trench to a specific level with calcium carbonate powder insulation, covering the insulation with a vapor barrier and then backfill to the final elevation.

At each site, potential problem areas were identified using infrared imaging. The survey team excavated and instrumented 11 WSL installations and four LFI systems which have been in service from one to 21 years. Results showed that both WSL and LFI systems had higher heat losses than expected.

ANALYSIS OF CERL AND CRREL SURVEYS

Over the past few years, the Federal Agency Committee on UHDS through CERL and CRREL, has conducted surveys of the different types of pre-approved underground steam and high temperature hot water distribution systems. Various DDT systems were tested with air pressure to determine casing integrity. Several WSL and LFI systems were subjected to infrared scanning to determine problem areas by heat loss analysis.

Results of these tests cause doubt whether DDT, WSL or LFI systems would function properly for long periods of time. Unfortunately a heat loss analysis of all three types of systems was not performed, therefore, it cannot be stated with certainty as to which system would function more satisfactorily over time. What is evident is that changes to all types of systems must be taken to improve the efficiency and longevity of their systems.

NEW CRITERIA

After results of the surveys were analyzed, the Federal Agency Committee and experts in the Corps of Engineers met and established guidelines for new criteria for UHDS. The Corps Mobile District prepared the new specification and after several iterations the new criteria is complete. Like all Corps criteria the specification is a "living document" and there will be changes in the future.

CHANGES TO CRITERIA FOR UHDS

There were many changes but the major changes are:

- No prequalification
- No fiberglass casings for the air space type of system
- Gland type end seals not allowed
- Thicker casings
- Thicker insulation

- Cathodic protection always required for steel cased systems
- Thermal performance test required for acceptance of installed system

HOPES FOR THE FUTURE OF UHDS

- More low temperature heating applications
- Higher temperature resistant coatings
- Greater efficiency
- Availability of an industry standard for UHDS

INDUSTRY INITIATIVES

Industry should develop standards for prefabricated piping systems; however the only standard in use today is the Corps guide specification. The other services, Department of Veterans Affairs, local municipalities and universities have made inquiries regarding our latest criteria and intend to use the Corps criteria. Presently there is no effort by industry to prepare a standard.

RESEARCH AND DEVELOPMENT EFFORTS

OVERVIEW

Army, Navy and other government agency laboratories have been involved in R&D of various aspects of heat distribution systems. Specific areas presently being addressed include heat loss assumptions and calculations, improving system designs and maintenance and leak detection systems for buried piping systems.

NOTABLE EFFORTS

Fort Jackson, SC

At Fort Jackson, CERL and CRREL have instrumented a trench and a direct buried system to measure heat loss. The goal is to record and compare long term experience, maintenance efforts and costs, any long term deterioration, and experience with leak detection technology.

COMPUTER DESIGN TOOLS FOR HEAT DISTRIBUTION SYSTEM DESIGNERS

TYPICAL CADD (COMPUTER AIDED DESIGN AND DRAFTING) DETAILS

Typical CADD (Computer Aided Design and Drafting) details are available from the Tri-Service CADD/GIS Technology Center CADD Details Library. The details are contained on a CDROM disk which will be available throughout the Corps. The details are compatible with Intergraph and AutoCad. The heat distribution system details originated from the details in TM 5-810-17. The details are intended not to provide "Standard Details" but to furnish CADD users with a starting point for the development of project-specific details. For more information contact Mr. Justin Taylor, CEMP-EE (telephone 202-761-1246).

STEAM HEAT DISTRIBUTION PROGRAM

The Steam Heat Distribution Program (SHDP) has been developed which calculates steam distribution system flows, pressures, and thermal efficiency. SHDP can be used to model new or existing systems and to determine the effects of system modifications. Accurate models of steam distribution systems can be developed relatively quickly, and modification of an existing model requires little additional work. SHDP is designed to run on a standard personal computer. For additional information contact Mr. Mike Brewer, CERL (tel 800-USA-CERL).

HEATMAP

The HeatMap program has been developed which allows designers to develop a computer model of district heating and cooling (DHC) systems. The HeatMap program is intended to simplify problem diagnosis and modification of existing systems and design of new DHC systems. It also allows the designer to compare various design scenarios even to comparing different heating media (ie steam or low temperature hot water). HeatMap interfaces with distribution system drawings in AutoCAD. For additional information contact Mr. Mike Brewer, CERL (tel 800-USA-CERL).

CONCLUSION

The energy efficiency of a heat distribution system is directly related to the quality of its design. Improvements in performance of heat distribution systems including criteria changes and use of better products are continually being reviewed by the services. Dissemination of changes in criteria will be in technical manuals and Corps guide specifications. New systems

will be evaluated and requirements included in criteria when found acceptable.

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